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Naval Research Advisory
Committee Report

Unmanned Vehicles (UV) In Mine Countermeasures (U)

November 2000

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J.M. Bachkosky, T. Brancati, D.R. Conley, J.W. Douglass, P.A. Gale, D. Held, L.R. Hettche, J.R. Luyten, I.C. Peden, R.L. Rumpf, A. Salkind, J.M. Sinnett, K.A. Smith, G.E. Whistler, Jr.,

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Naval Research Advisory Committee
800 North Quincy Street
Arlington, VA 22217-5660

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Assistant Secretary of the Navy (Research, Development and Acquisition)
1000 Navy Pentagon
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13. ABSTRACT (Maximum 200 words)

(U) The study addresses the application and identification of alternatives for Unmanned Vehicles (UVs) in Mine Countermeasures (MCM) operations. The panel reviewed current programs under development to determine gaps and overlaps and made recommendations for future UV requirements.

(U) In future joint littoral warfare naval mines will be among the asymmetric threats of most concern. This problem is unique to the Naval Services. At the outset it must be noted that there is no "silver bullet" in MCM. The different types of mines and environmental conditions argue for a robust, flexible "system of systems." Technology will not support single platforms or sensors with the required capability to perform the MCM mission. Additionally, the Commander's operational requirement will be situation dependent; while in other cases neutralization may be necessary. Therefore, an approach with vehicles and sensors tailored to different functions, and netted together, appears to be the most practical, feasible, and cost effective.

(U) A family of UVs and sensor systems would provide end-to-end capability over the broad littoral environment; vehicles which are clandestine, affordable, and virtually expendable. Additionally, the DoN should stay the course with respect to the programs under development today, in order to field them, learn from them in an operational environment, and fully exploit the technology. There are surf zone S&T programs under way which should be pushed to demonstration. The foregoing will require sustained investment in UV and sensor technology, while concurrently maintaining resources in the developmental systems.

(U) There is great potential for UVs to make a sizeable contribution towards meeting the naval mine threat. It is recommended that the DON pursue this capability with new emphasis. Programs now under way represent only a beginning and must be kept on track, while investments are made to work high end technical issues. The area of first priority to develop and demonstrate affordable systems in is the Very Shallow Water and Surf Zone domains where humans are most vulnerable. These developments must be supported by an integrated Concept of Operations. The report contains a number of specific technical recommendations to advance the Naval Services' capability in mine countermeasures.

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Naval Research Advisory Committee

Unmanned Vehicles in Mine Countermeasures

Executive Summary

(U) In February 1999 the Naval Research Advisory Committee (NRAC) was tasked by the Honorable H. Lee Buchanan, Assistant Secretary of the Navy (Research, Development and Acquisition) [ASN(RD&A)], to conduct a study to determine the application of Unmanned Vehicles (UVs) in Mine Countermeasures (MCM) Operations and to identify alternatives. The tasking included a review of current programs under development, with a view toward determining gaps and overlaps. Based on the findings, the study was to make recommendations for future UV requirements. The Office of the Chief of Naval Operations (OPNAV) sponsor for the study was Major General Dennis Krupp, USMC, Director Expeditionary Warfare (N85). In order to address the broad range of issues associated with UVs in mine warfare, a panel of eight NRAC members was augmented with experts from industry and government as well as three retired flag/general officers with mine warfare experience.

(U) As we look to future joint littoral warfare and the challenge that will face our warfighters, there is little doubt that naval mines will be among the asymmetric threats of most concern. This problem is unique to the Department of the Navy (DON), and while our current mine force is the best in the world, it is only pacing the threat. It must be modernized with more capable systems to not only fill the gaps in today's capability, but also to infuse new capabilities that can meet the anticipated threat in the new millennium. Given the inherent danger in dealing with the naval mine threat coupled with zero public tolerance for casualties and overall initiatives to replace manpower with technology, a review to determine the potential contribution of unmanned systems is timely and appropriate. At the outset it must be noted that there is no "silver bullet" in MCM. The different types of threat mines and environmental conditions that will face our Naval Forces argue for a "system of systems" which is robust and flexible enough to operate in regimes from waters in excess of 200 feet in depth to the Surf Zone (SZ) and Craft Landing Zone (CLZ) on the beach. Technology will not support single platforms or sensors with the required capability, namely to perform the MCM mission across the spectrum of threats.

(U) Additionally, the Commander's operational requirement for dealing with naval mines will be situation dependent. In some cases the location of mines will be sufficient for avoidance, while in other cases neutralization may be necessary. Therefore, an approach that incorporates vehicles and sensors tailored to different functions and communicating together as a network appears to be the most practical, feasible, and least costly way to proceed.

(U) The panel concluded that UVs have an increasingly important role in the MCM mission, and that Naval Forces will therefore require a family of UVs and sensor systems to provide end-to-end capability over the broad littoral environment. The vehicles will need to be clandestine, affordable, and expendable. The panel underscored that there is neither a capability today against mines in the surf zone,

nor a capability for location or neutralization of buried mines from UVs. Finally, it determined the necessity to stay the course with respect to the programs under development today which in some cases are admittedly very large and expensive, in order to field them, learn from them in an operational environment, and fully exploit the technology. Consistent with the foregoing, there are SZ Science and Technology (S&T) programs under way which must be pushed to demonstration soonest. The foregoing will require sustained investment in UV and sensor technology, while concurrently maintaining resources in the developmental systems.

(U) The following are desirable capabilities for UV MCM systems:

- ability to bottom map, assess the environment, and fulfill the detect-to-engage sequence; i.e. detect, classify, and identify (or provide a high degree of certainty) the presence of naval mines, successfully discriminating them from the numerous and ever present non-mine bottom objects (NOMBOs)
- precise navigation which allows for a common tactical picture and provides for safe navigation, mine avoidance, and reacquisition if necessary for neutralization purposes
- speed in conduct of the mission, which applies not only to the speed at which MCM platforms can cover a threat area, but also to the speed of data exchange, processing and fusion of information
- minimum radar, magnetic, and acoustic signatures
- ability to operate in the SZ
- power of sufficient capacity to support propulsion and combat systems (sensors, onboard computer, communications, and neutralization)
- robustness and durability to perform reliably in a hazardous environment
- vehicle size/footprint reduced to the degree that technology can allow to facilitate handling and flexibility with respect to transportation and deployment
- ease of launch and recovery

(U) The panel identified a number of technology long poles relative to the above capabilities. Operating in the very shallow water (VSW) and SZ (40 feet or less) makes underwater communications more difficult and variable. As operations move onto the beach where ground robotics might be applicable, these systems remain to be proven, particularly given the threat posed by buried mines and obstacles. Precise underwater navigation must be achieved in all depths, as must data fusion for a common tactical picture. Assured neutralization remains a high-end challenge; successful hunting is the primary countermeasure today. Challenges associated with the launching of vehicles will extend from a situation of relative ease for those such as unmanned air and surface vehicles operating at great distances from the shore, to one of difficulty for those vehicles that must be inserted into very shallow depths or the SZ, or underwater in moderate sea states. Finally, as history will reflect, the ability to reduce the size and cost of the vehicles and their sensors while increasing reliability and capability will most likely be the greatest challenge.

(U) As noted earlier, the most economical approach is to tailor the individual elements of the family of vehicles to the domain in which each has the best potential for effective operation. The study concluded that the shallow and deep water domains (40 feet and greater) can be effectively covered by autonomous or remotely controlled low observable surface and underwater vehicles when tactical surprise is not required. When clandestine operations are a requirement, the totally submersible Unmanned Underwater Vehicle (UUV) is the only solution; however, it must be noted that the technical risk for precise navigation and communications will increase significantly. The VSW domain (10 feet to 40 feet) that is covered today by human divers and marine mammals may call for the Unmanned Air Vehicle (UAV) and Unmanned Surface Vehicle (USV), complemented by the UUV at the deep end, and the Unmanned Ground Vehicle (UGV), such as a crawling vehicle at the shallow end. Tactical surprise and survivability of the surface/air vehicles are then factors the operational commander will have to take into consideration. Finally, the SZ and CLZ (0 feet to 10 feet) can only be addressed by the UAV and UGV with associated risks previously discussed.

(U) The panel recommends that a number of steps be taken concurrently to advance the DON capability to use UVs in mine countermeasures:

- Solve key technical problems. Increase S&T effort in biosonars/buried mine detection. Elevate priority of work on sensor data interpretation and fusion. Maintain long-term investments to solve power, acoustic and non-acoustic communications, sensors, precise navigation, and autonomous control. In doing so, leverage investments in UV technologies with Army, industry, and other government agencies and academia.
- Develop a family of UV system capabilities for end-to-end coverage throughout the threat environment. Stress modular design, minimal weight and footprint, and innovative launch and recovery systems, while driving down acquisition and life cycle costs.
- Advance the mine warfare competency. Expedite fielding and demonstration of MCM UV programs under development and acquisition, and incorporate UV technology into future MCM programs.
- Expand the MCM Concept of Operations (CONOPS) to fully integrate UVs into the mine warfare mission. This CONOPS must have end-to-end capability, and be an iterative process as technology evolves. This will, in turn, provide the requirements for S&T programs.

(U) In summary, the UV MCM panel found great potential for UVs to make a sizeable contribution towards meeting the naval mine threat, and recommends that the DON pursue this capability with new emphasis. There must be a concerted effort in sensor development. Programs currently supported represent only a beginning and must be kept on track while investments are made to work the more difficult technical issues. The area of first priority to develop and demonstrate affordable systems is in the VSW and SZ domains where humans are most vulnerable. These developments must be supported by an integrated CONOPS.

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Terms of Reference

OBJECTIVES: To state the requirement for UVs that would operate in support of the mine warfare mission. Identify the UV alternatives which apply to the mine countermeasures mission, describe them, assess their pros and cons, review the current development programs, identify gaps and overlaps. Report findings and recommendations.

OPNAV Sponsor:

Major General Dennis Krupp, USMC
Director, Expeditionary Warfare (N85),
Office of the Chief of Naval Operations

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Naval Research Advisory Committee

Terms of Reference

(U) In February, 1999, the NRAC was tasked by the Honorable H. Lee Buchanan, ASN(RD&A) to conduct a study that would examine the role of UVs in the MCM. The study was designed to address issues related to existing programs for utilizing UVs, to assess and evaluate the technologies, identify alternatives and identify gaps and potential blockers.

(U) The sponsor for this study was Major General Dennis Krupp, USMC, Director, Expeditionary Warfare (N85), OPNAV.

(U) In the context of this study, a UV is a system free to move under its own power and control, with varying levels of autonomy. We will distinguish various types of UVs: Air, Ground, Underwater and Surface (UAV, UGV, UUV, and USV). Because of the constraints of time and opportunity, much of the study relates to the UUV, although other types were studied as well.

(U) The complete Terms of Reference may be found in Appendix A.

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Panel Membership

Chairperson		
Dr. James R. Luyten	Senior Associate Director	Woods Hole Oceanographic Institution
Vice-Chairperson		
Mr. Peter A. Gale	Chief Naval Architect	John J. McMullen Associates, Inc.
Mr. John "Jack" M. Bachkosky	Chief Operating Officer	System Planning Corporation
Mr. Thomas Brancati	Chief Executive Officer	California Preferred Provider Group, Inc
RADM Dennis R. Conley USN (Ret)	Private Consultant	
The Honorable John W. Douglass	President and CEO	Aerospace Industries Association
Dr. Daniel Held	Director and Chief Scientist	Northrop Grumman Corporation
Dr. L. Raymond Hettche	Director, Applied Research Laboratory	Pennsylvania State University
Dr. Irene C. Peden	Professor Emerita (Electrical Engineering)	University of Washington
Mr. Richard L. Rumpf	President	Rumpf Associates International
Dr. Alvin Salkind	Associate Dean (College of Engineering)	Rutgers, The State University of NJ
Mr. James M. Sinnett	Vice President Strategic Development	Phantom Works, The Boeing Company
LtGen Keith A. Smith USMCR (Ret)	Private Consultant	
RADM Glenn E. Whisler, Jr., USN (Ret)	Director, Technology Development	LOGICON Information Systems and Services
Executive Secretary		
CAPT Robert Schnoor, USN	Deputy Head, Ocean, Atmosphere, and Space S&T Department	Office of Naval Research

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Panel Membership

(U) The panel was composed of a well-balanced team of experts with diverse backgrounds and points of view on UVs and MCM. Fourteen individuals, eight of whom are members of NRAC, brought broad expertise to this study from backgrounds in industry, the academic research community, government and the military. Three panel members were retired flag or general officers. Specific technical areas of expertise include sensor development, electromagnetic and acoustic remote sensing, aerospace technology, naval architecture, oceanography, and battery and power technology.

(U) Dr. James R. Luyten chaired the panel. Mr. Peter A. Gale and Dr. Irene C. Peden served as Vice Chair during different phases of the study, and Captain Robert Schnoor, USN, Deputy Head, Ocean, Atmosphere and Space S&T Department of the Office of Naval Research (ONR), was the Executive Secretary.

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Visits (32), Briefings (74), and Sources

FLEET & HQ

OPNAV N85, N852, N853,
COMTHIRDFLT
1MEF
USS CHIEF
USS BONHOMME RICHARD
COMMINEWARCOM
MCMRON THREE
VSW MCM DET
COMOMAG
ACU FIVE
COMEODGRU ONE
AIRMCMRON FIFTEEN
MINE WARFARE TRAINING CTR
OFFICE OF NAVAL INTELLIGENCE
MCCDC

ACADEMIA

MIT
WOODS HOLE
SCRIPPS
UVA
MIT SEA GRANT
PENN STATE- ARL
UNIV TX- ARL
JHU-ARL
FL ATLANTIC UNIV
NORWAY UNIV S&T

S&T/ACQUISITION

ONR, ONR IFO, AFOSR
NRL, ARL, AFRL
DARPA
MCCDC
NAVSEASYSCOM PEO(MIW)
PMS 407, PMS 403, PMS (EOD)
NAVAIRSYSCOM PEO (CU)
SPAWARSYSCOM SSC (MMS)
NUWC NEWPORT
NSWC CSS
NSWC SFOMC
DEFENSE RESEARCH ESTABLISHMENT (NORWAY)
DIVISION OF UNDERWATER DEFENSE (NORWAY)
CNN TECH (SWEDEN)
SSPA HYDRO TEST LAB (SWEDEN)

INDUSTRY

MIRAGE SYSTEMS
RAYTHEON SYSTEMS CORP
KAMAN AEROSPACE CORP
IS ROBOTICS INC
FOSTER-MILLER INC
BLUEFIN ROBOTICS INC
NUI (NORWAY)
SAAB ERICSSON SPACE
ERICSSON MICROWAVE
KaMeWa PROPULSION SYS
BLOHM & VOSS (FRG)
HDW SHIPYARDS (FRG)

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Visits and Briefings

(U) The Panel made 32 visits and received 74 briefings from the Fleet, Headquarters, the S&T and acquisition communities, industry and the academic research community dealing with mine warfare, unmanned vehicles, sensors and operational concerns. A complete listing can be found in Appendix B.

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Why Now?

- Growing threat
- Complex environment
- Reduce personnel in harm's way
- Unmanned vehicle system technologies may be the only viable solution
- Unique Naval problem

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Why study this problem today?

(U) Intelligence sources reflect a growing naval mine threat. Mines are cheap, and there is an industry making them cheaper, smarter, stealthier, and less expensive by comparison with other weapons. The environment in which mines must be countered is extremely complex containing not only a wide variety of mines and mine-like objects, but small scale oceanographic and meteorological phenomena which affect and limit the performance of sensors. It is also a dangerous environment in which people and marine mammals are put in harm's way, even under the best of circumstances.

(U) UV technologies may provide the only viable alternative. The technologies that underlie and enable UVs are continuing to advance, driven by the cellular phone and computer industries. Improved power sources, miniaturization and autonomous control are among the benefits. All of these technologies favor small systems with on-board intelligence.

(U) This is a unique DON problem; no one else is going to solve it.

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Conclusions: Preview

- Virtually no current MCM capability against mines in the Surf Zone
  - No viable alternative to Marine Mammals for buried mines
  - Not enough sustained investment in UV and sensor technology–SW through CLZ
- History of MCM Programs: expensive, slow operations, acquisitions cancelled before units are fielded and fully exploited
- Need family of UV and sensor systems to solve MCM from deep water through CLZ: clandestine, affordable and expendable
- UV technology is maturing

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Conclusions: Preview

(U) In reviewing the current capability for MCM, we found that there is virtually none against mines in the SZ and VSW (0 feet - 40 feet), except for human swimmers and marine mammals. In addition, there is no viable alternative to the few available marine mammals for finding buried mines.

(U) We found that while UVs have great potential for use in these environments, appropriate sensor development has lagged. The panel observed that there has not been sufficient sustained investment in sensor technology for application in the Shallow Water (SW) through to the CLZ.

(U) The history reveals that the arrival of new technology and systems designed for the MCM forces has been very slow. Systems are expensive and they grow to encompass multiple missions. They take a very long time to reach the Fleet, or are cancelled before they reach the field for full exploitation. As a consequence, little is learned from these developments, and systems wither on the vine.

(U) No single system can be effective over the full range of the MCM mission. What will be needed is a family of unmanned systems to solve the MCM problem from deep water through to the CLZ. Such systems need to be clandestine, affordable, and where appropriate, expendable.

(U) The panel found that UV technology is maturing. There are systems being used both in industry and in the research community. UUVs are available for oil exploration, for siting pipelines, reconnaissance inside large pipelines, high resolution bathymetric and topographic surveys in a fully autonomous mode at full

ocean depth [> 4000 meters (m)]. UAVs are being used for high resolution topographic surveys and reconnaissance, and UGVs are used in hazardous environments for a variety of tasks.

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Recommendations: Preview

- Increase S&T investment on buried mines
- Push Surf Zone S&T programs to demonstration
- Drive down cost of unmanned systems
- Get systems in pipeline out to Fleet NOW

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Recommendations: Preview

(U) In view of our concerns about buried mines, and seeing no viable alternative to the marine mammals at this time, we urge a concerted S&T effort to understand why these animals are so effective at finding buried mines, and to develop suitable alternative sensors and systems to meet this important challenge.

(U) Some ONR 6.2 and 6.3 programs for technologies that are effective in the SZ need to be pushed to demonstration, so that these technologies can be fully evaluated.

(U) There must be a concerted effort to drive down the cost of unmanned systems. Whereas much of the technological innovation is being driven by the laptop computer and cellular phone industries, the acquisition processes seem to reap few of the benefits from these innovations.

(U) There must be a concerted effort to get systems currently in the acquisition pipeline out to the Fleet, so that the operators can learn how to use them in an operational context. The lessons learned can then be applied to subsequent developments.

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The Bottom Line

UVs can

- be clandestine
- be force multiplier
- be replacement for humans/mammals

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The Bottom Line

(U) The panel's view is that UVs, when coupled with appropriate sensors, offer a unique opportunity for providing support for the MCM mission that is clandestine and able to reduce the exposure of humans and marine mammals to harm. If the potential for large numbers of inexpensive, small, networked vehicles is realized, these can serve as significant force multipliers. We believe that UVs will have an increasingly important role in littoral warfare and in MCM in particular.

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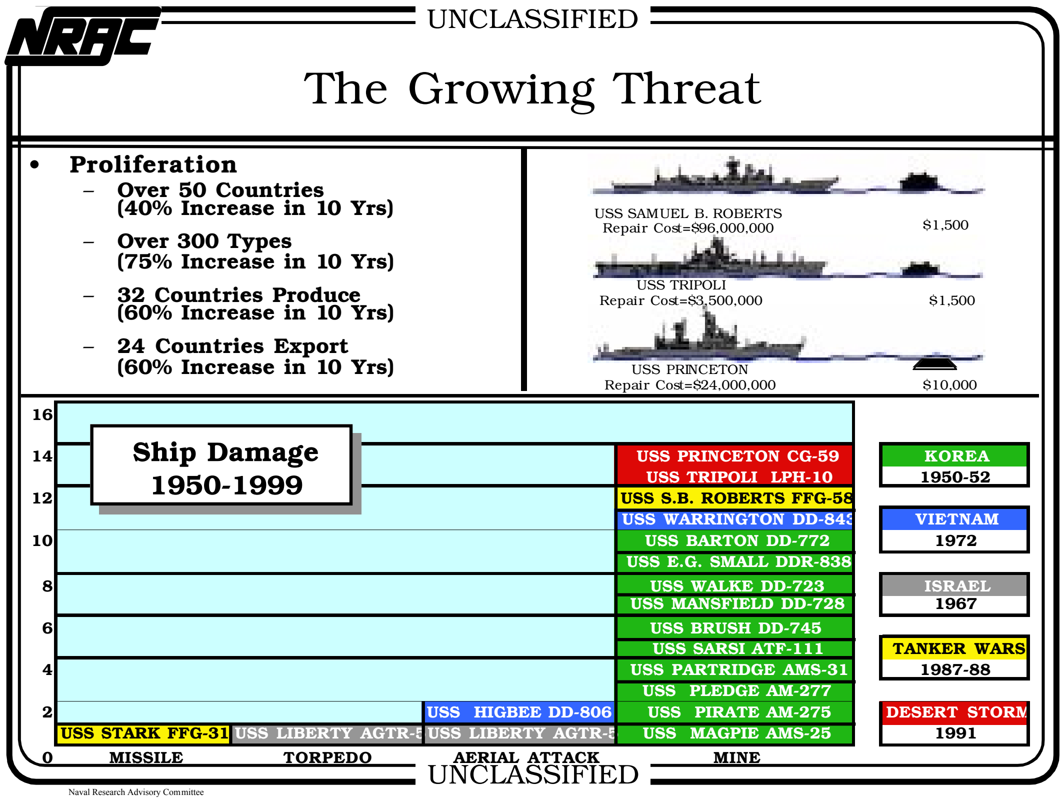

The Growing Threat

(U) The threat to our military forces has been increasing because of the vast proliferation of the numbers of countries using, producing and exporting mines over the past ten years. In addition, there are now over 300 types of mines, with an increasing level of sophistication in both how mines are triggered and how their signatures appear to acoustic sensors.

(U) The use of mines is highly asymmetric. In three recent incidents, the damage suffered was vastly greater than the original cost of the mine.

(U) In the past 50 years, most of the damage suffered by U.S. Naval Forces has been due to mines. Fourteen incidents involving mines are recorded, while missile, torpedo, or air attack accounted for a total of four.

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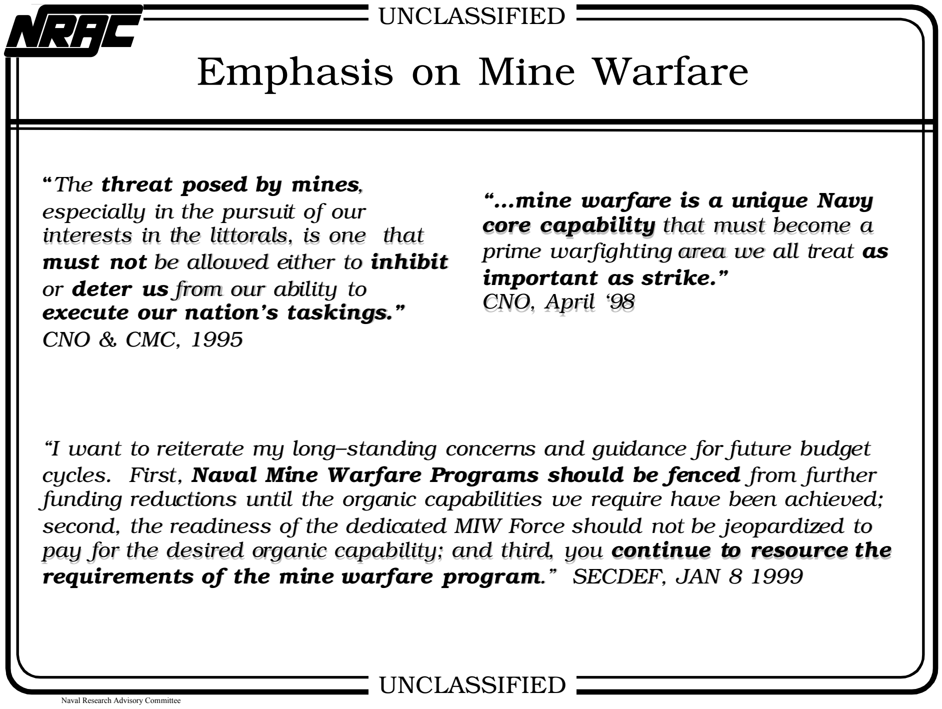

Emphasis on Mine Warfare

(U) Mine warfare has recently received significant attention at high levels in both the Department of Defense (DoD) and DON, suggesting that the capability for Mine Countermeasures is as important as that of Strike.

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Mine Warfare Today

(U) This slide shows a trend in mine warfare that we believe is relevant to this study. The two loops illustrate cycles that occur for both adversary mine layers and U.S. mine countermeasures.

(U) The bottom line is that, for several reasons, the development of mines has outpaced that of mine clearing technologies. This trend had accelerated by the end of the cold war. Subsequently, as Research and Development (R&D) budgets decline, mine clearing must compete with other demands for scarce R&D funding. Hence, progress indicated by the clock hand in the loop on the left has slowed down; it stands at approximately 0700 at this time.

(U) The other side of the chart shows the influence on the fact that mines are cheap and plentiful. They offer great potential for low cost leverage to nations that cannot challenge the U.S. or its allies in conventional naval engagements. This has accelerated progress in the loop on the right.

(U) The result is a need on the MCM side for sustained investment in mine clearing technology to close the gap. Without such an investment program, the gap is likely to increase to the point where current doctrine on naval warfare could become obsolete. The panel believes that the DON cannot wait to close the gap between the offense and defense in mine warfare until this country experiences a disaster along the lines expressed by the Secretary of Defense (SECDEF) in his

November, 1997, letter and follow-on memos to the Secretary of the Navy (SECNAV). [1]

[1] See Appendix C.

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Cultural Observations

- Previous naval emphasis on countermine mission was not commensurate to the threat
- Cultural acceptance of unmanned systems in Naval Forces improving -- they work & reduce risk
- Increased use of UVs in the countermine mission will require sustained investment (to field affordable, effective and reliable systems) and continuing cultural change (for total acceptance)

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Cultural Observations

(U) In the past, the naval emphasis on MCM has not been commensurate with the threat. Concern exists that the need for investment in new and innovative technology will face difficulty in the current fiscal environment.

(U) All the Services reflect skepticism when it comes to investing in technology to replace activities now carried out by humans. However, the Naval Forces have demonstrated acceptance of unmanned systems; i.e. Tomahawk, torpedoes, etc. If the full capabilities of unmanned systems are to be realized, a sustained investment to field affordable, effective and reliable systems will be required, together with continued cultural change to assure total acceptance.

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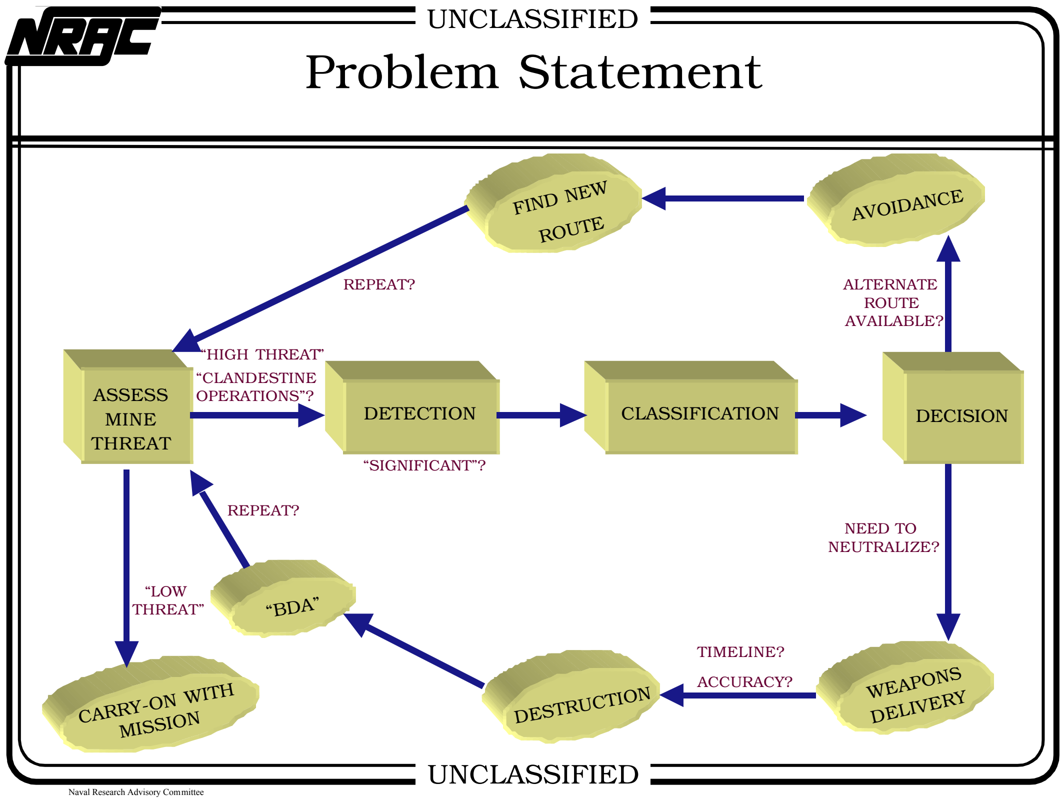

Problem Statement

(U) This slide illustrates the MCM problem. In essence, there is a balance between risk and time.

(U) The first step is depicted on the left side; namely, assess the threat. If it is a low risk threat, the obvious decision is to proceed with the mission. If the assessment is that there is a high threat potential, reconnaissance/detection procedures follow. In the face of significant target detections, next steps are localization and classification. Time is at a premium for the detection-through-classification processes. Depending upon the overall situation, clandestine operations may be required.

(U) The next step is one of decision. What is the risk involved? How time-critical are the emerging operations? Are alternate routes available? Must the threat be neutralized? Should the mission be aborted?

(U) If alternate routes are available (and desirable), then "avoidance" is the path of choice. A new route must be found, and the process begun anew, or all over. If the decision is to neutralize the threat, a suitable weapon delivery mechanism must be deployed consonant with timelines, accuracy and the need for clandestine operations. Destruction of the threat provides a major risk reduction if it can be accomplished with confidence. A remaining critical move is battle damage assessment (BDA) and the balance of risk and time.

(U) Successful prosecution of the threat leads to the decision to carry-on with the mission.

(U) The critical issue here is that this process is presently done serially - one goes through the detection/classification processes by having to reacquire the detected objects in order to classify them, and to do so again if there is a decision to neutralize. This is not only very time consuming, but it also puts the MCM forces at risk, since little of the required action can be carried out clandestinely at present.

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Complex Littoral Environment

Obstacles and Mines

- Concertina wire
- Moats
- Trip wires
- Hedgehogs
- Concrete blocks
- Fishing gear

- Anti-personnel mines
- Anti-tank (vehicles) mines
- Anti-invasion mines

- Buried/Bottom mines
- Floating mines
- Moored/Tethered mines
- Rocket propelled mines
- Inert decoy mines
- Non-mine bottom Objects

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Complex Littoral Environment - 1

(U) When all types of mines and obstacles are properly deployed in a defensive profile, this environment constitutes the most vexing enemy threat in the world's littoral areas. Not only are there many kinds of mines, but as noted previously, their sophistication is increasing. Newer types encased in plastic are harder to locate in most environments since these have few metal components, and shapes can mimic rocks or other natural objects. While no one would expect to face a situation in which all of these threats were realized together, the DON must be prepared to counter any of them.

(U) In addition, a rogue nation or terrorist organization could use mines to effectively close navigational choke points or straits essential to continuation of world trade. The exorbitant time required to clear the passage, locate, neutralize and verify, utilizing existing free world countermine forces, could result in catastrophic disruption of world commerce.

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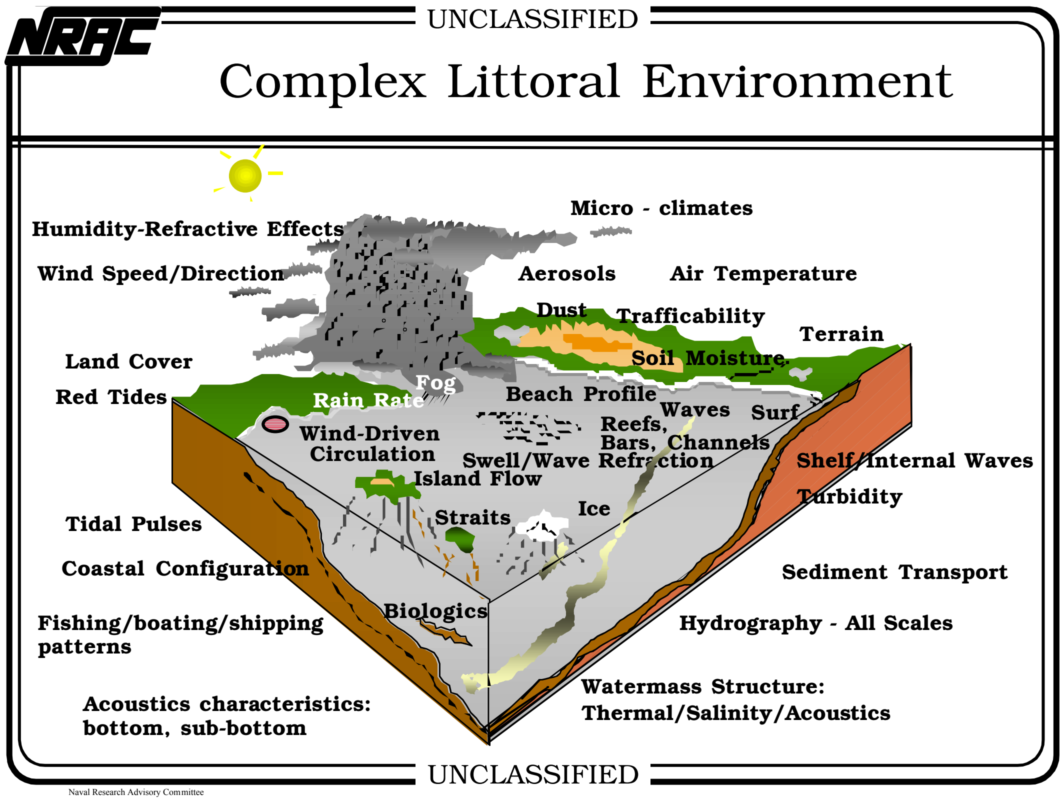

Complex Littoral Environment - 2

(U) The physical environment is also complex. This view illustrates the variety of ocean and atmospheric processes that may affect the land and the sea along a coastal region.

(U) The littoral regions are characterized by intense small-scale variability in their meteorology, geology, ecology and oceanography. They offer one of the most challenging environments in which to predict ocean currents or weather, as well as offshore topography and bathymetry.

(U) Depending upon the location, one may need to deal with plunging surface, ice, turbidity, suspended sediment and bioluminescence, as well as with rapidly changing sound speed, temperature and salinity fields in both time and space, due to the propagation of fronts. One of the consequences of this complexity is that acoustic or optical sensors which perform adequately or predictably in one environment, may not work as well in another. Relying upon climatology to determine sensor performance may be very misleading. The physical environment is further complicated by the presence of local fishing fleets and their gear, which may be deployed or just left to drift or litter the ocean bottom.

(U) Storms can reconfigure a mine field, the bottom profile and the beach profile in a matter of days or weeks, requiring extensive reconnaissance before preparing for a mission.

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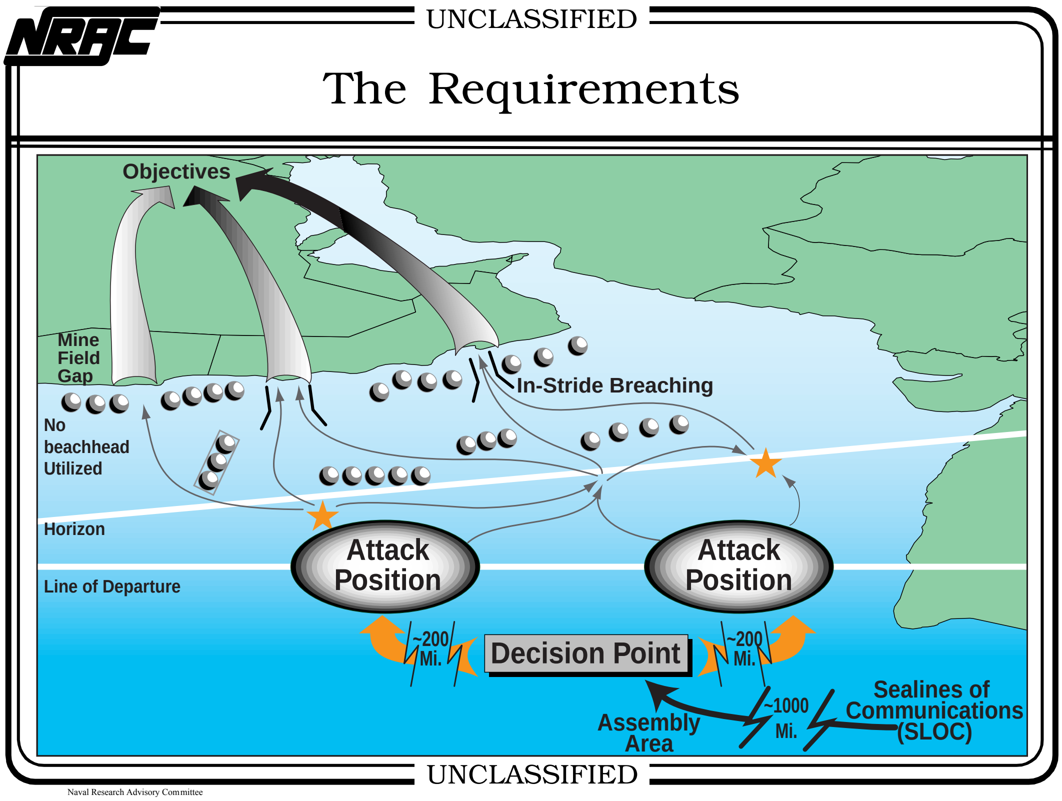


The Requirements

(U) The MCM mission must provide for mine clearance for checkpoints, straits, and the full length of the lines of communication as well as for projection of power ashore. There have been on-going evolutionary changes to doctrine and tactics that capitalize on the full potential of our current capabilities. These changes in tactics and doctrine have not solved the mine threat in the CLZ to 40' water depth; however, the emerging tactics do offer an alternative of going around or over a mined beach.

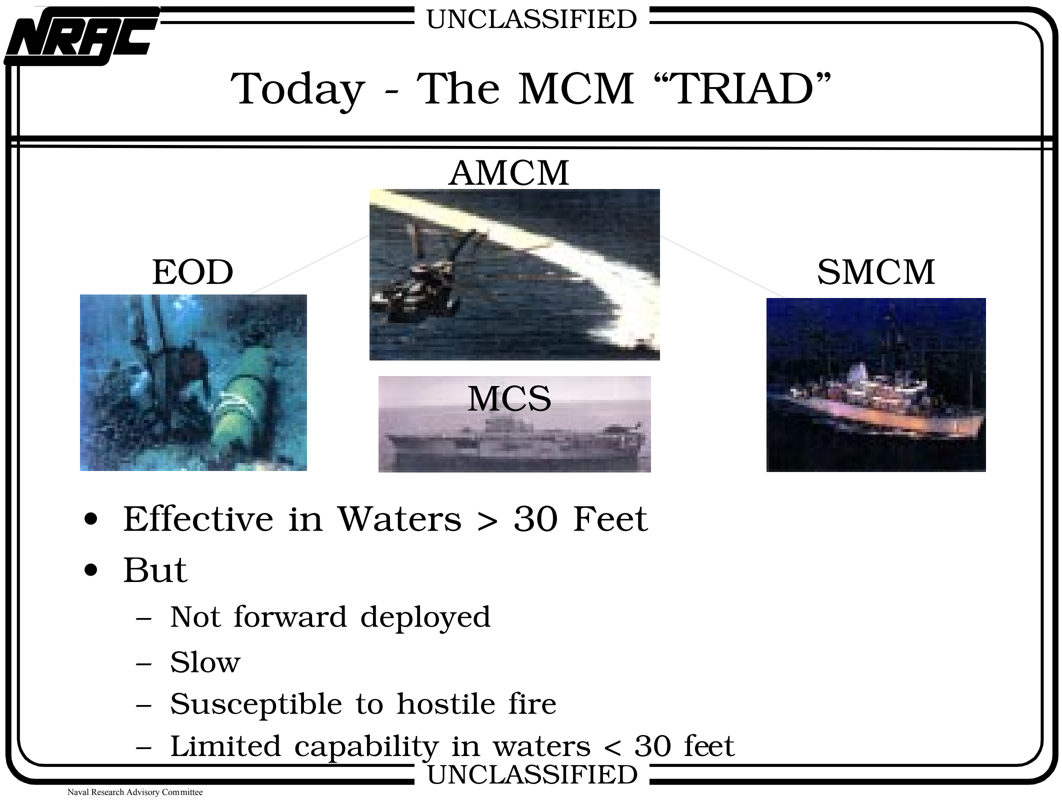
(U) It is not a simple matter to provide for command and control of forces that can encompass Sea Lines of Communication (SLOC) security, power projection over the beach, and countermine security to keep world commerce flowing.

(U) From the point of view of the Joint Task Force Commander (JTFC), these areas are all question marks. The commander must detect, classify and identify the construct of the mine threat, assess the viability of gaps, determine the potential for in-stride penetration and issue an operations order. The order might direct exploitation of the gaps, direct minefield clearance for surface assault, or order vertical envelopment, or any combination of the above, including all of them.

(U) The requirement to clear the mined area remains. The order must provide mine clearance of an area large enough in capacity to provide for the unloading of the huge volumes of materiel and warfighting personnel required to exploit the initial attack and conduct subsequent operations ashore, if required.

(U) Accomplishment of the mine clearance requirement at present may involve several days. What has really changed is the requirement to accomplish this either clandestinely, or in a matter of hours once the assault has begun.

(U) The slide displays a notional array of SLOCS, a decision point, attack points, and minefield gaps, together with in-stride and vertical envelopment options.



Today - The MCM "Triad"

(U) Today the DON has an effective MCM force composed of helicopters, surface ships and Explosive Ordinance Detachment (EOD) forces. Working together, these forces have significantly reduced the time lines needed to prepare the battlespace for naval operations.

(U) The size of the Mine Force (26 ships, 24 aircraft, and 17 EODs) precludes having this capability forward deployed with the battle groups and amphibious ready groups. However, two ships are forward deployed to Sasebo, Japan, and Manama, Bahrain, and there are four MH-53 airborne mine countermeasures (AMCM) helicopters in Bahrain.

(U) While time lines have shortened, current sensors require repeated acquisition of contacts to determine whether they are mine-like or NOMBOs to make positive identification and then to reacquire for neutralization, as needed.

(U) The employment of sensors from ships and helicopters becomes limited at a depth of approximately 30 feet due to navigation and environmental factors, creating heavy reliance on the human divers and marine mammal capability resident in our EODs. The human diver component is most effective in water shallower than 30 feet. As water depth increases beyond 30 feet, time and human factors (endurance, need for decompression) make other methods for identification and neutralization (mammals, shipboard and airborne sensors) more attractive.

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MCM Systems in Very Shallow Water and the Surf Zone (U)

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(U) Two systems are in acquisition for the SZ, namely Secured Airborne Radar Equipment (SABRE) and Distributed Explosive Technology (DET), explosive nets and line charges. They are to be launched from a Landing Craft Air Cushion (LCAC) for clearing and breaching up to the CLZ. These systems add considerably to the vulnerability of the landing craft supporting them, as well as requiring a large footprint and logistics component.

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Findings: Operational

- Limitations of current MCM CONOPS:
  - No prescribed role for UVs
  - No roadmap for integration of UVs
  - Provides no requirements for UV R&D programs
  - Tend to be system specific
- Past MCM exercises and technology demonstrations have been limited to only a few environments and threat scenarios
  - Systems engineering approach is essential

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Findings: Operational

(U) The panel's findings are separated into those related to operational issues and those that are essentially technical. From the operational point of view, we find that the use of unmanned systems has not yet been fully *integrated* into the MCM CONOPS. The MCM CONOPS does not prescribe the unmanned systems role, nor does it develop a roadmap for integration into the mine warfare mission. The CONOPS that do exist are mostly system-specific and do not address these larger issues.

(U) The CONOPS determine the requirements, which in turn drive the R&D programs toward filling technology holes.

(U) We are aware that an MCM CONOPS is being worked on at present, and hope that it will provide the integration that we believe is essential for the effective use of UVs systems across the entire MCM domain, including SLOC.

(U) We believe that the technology and system demonstrations need to be carried out in a context that is increasingly realistic about the threat and environment, as well as about appropriate time lines.

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Findings: Technical (U)

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(U) It is fair to say that limitations of the state-of-the-art in vehicles, sensors, computation, communications and navigation preclude the effective use of UV's from the VSW to the SZ. No current or near-term UV capability for underwater communications and precise navigation exists for the SZ. Recently initiated S&T programs offer opportunities for future demonstrations and transitions in the SZ to VSW.

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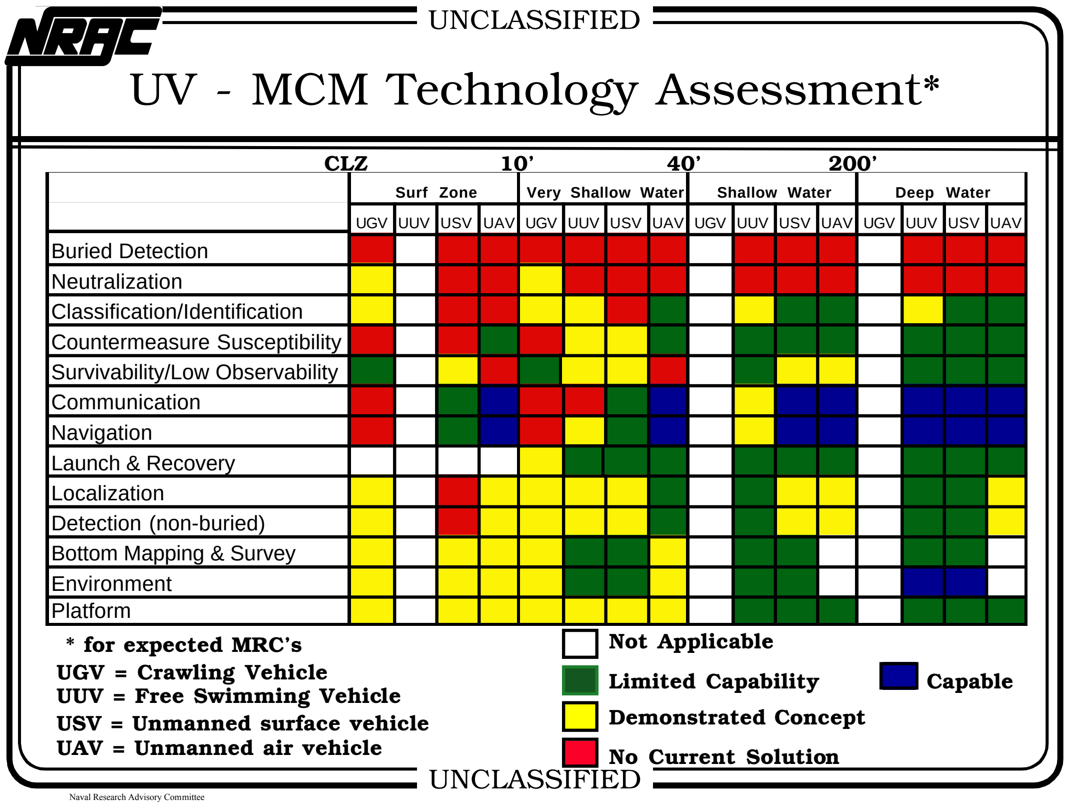

Unmanned Vehicle - MCM Technology Assessment

(U) The above slide represents the panel's assessment of the status of technologies for UVs for the MCM mission, within the context of Major Regional Conflicts (MRCs). We consider technologies' related capabilities, shown on the ordinate, for all types of UVs: ground, underwater, surface and air, in each of the four domains - SZ, VSW, Shallow Water and Deep Water (abscissa). In some cases, a capability is not applicable, such as the launch and recovery operation in the SZ wherein vehicles need to be launched in deeper water before moving into the SZ.

(U) Striking features of this chart include the significant and effective capabilities, e.g. communication and navigation, of UVs in deep water, some of which extend to shallower water.

(U) Another striking feature is the absence of any capability, even limited, for buried mine detection or neutralization from UVs, across the entire domain.

(U) In terms of platform issues, much of the DON's investment has been focussed on the UUV. The UV systems requiring additional resources and attention to bring them to a commensurate level of maturity are UAVs, USVs and UGVs (bottom crawlers). For UAVs, the limiting technologies are the sensors that can detect and localize surface and buried mines from VSW to the CLZ. There is no compelling need to develop a new UAV platform, but rather to build from existing UAVs (Pioneer, Predator and Hunter) and future systems Tactical Unmanned Aerial Vehicles (TUAV) (Army) and Vertical Takeoff Unmanned Aerial Vehicle (VTUAV) (Navy), utilizing them as the "trucks" for MCM sensors. Industry, the Department of

Energy (DOE) and the Army have developed relevant technologies for energy field detection and land mine detection which hold great promise for the MCM mission. Resources should be applied to demonstrate these Commercial Off the Shelf (COTS) Non-Developed Item (NDI) systems in realistic tests to determine the best mix of sensors to meet the MCM needs. Funding to bring into production the best sensor/sensor mix can then provide the required cost reduction for acquisition of the system.

(U) In the USV domain, the low observable Owl MK II System developed for the Explosive Ordnance Disposal/Low Intensity Conflicts Office of Special Technology and already in use by the DON, could serve as a test bed for evaluation of sensors, communication, navigation and launch and recovery operations in the various MCM domains. In the UGV (bottom crawler) domain various autonomous systems, e.g. lemmings, crabs, etc. should be demonstrated in real operational scenarios with countermeasures to evaluate detection and neutralization effectiveness against proud mines in the VSW and SZs.

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Operational Capabilities
Required Technical Developments

- **Surf Zone Deficiencies**
  - Ground Robotics
  - LIDAR
- **Underwater Communications**
  - Multi-path Transmission Solutions
  - Retractable Antennae (UHF)
  - Fiber Optics/Sonobuoy
- **Underwater Precise Navigation**
  - Retractable Antennae (GPS)
  - Fiber Optics/Sonobuoy
  - Autonomous Bottom Ref/Mapping System
  - Visual/GPS/Acoustic Lane Marker

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Operational Capabilities - Required Technical Developments - 1

(U) The next three slides present the panel's assessment of operational capabilities needed and potentially enabling technologies. Currently, the DON is investing the bulk of its UV resources for mine countermeasures warfare and mine field detection in UUV systems [platforms, sensors, and Command, Control and Communications (C^3)] which operate from deep water through SW.

(U) Critical technologies that currently limit the potential utility of UVs in all water zones include power supplies; (i.e. batteries/fuel cells) and acoustic and non-acoustic communication. Also needed are sensors designed specifically for use in the VSW and SZ where sound propagation is constantly changing and is affected by winds, wave motion, etc. Biomimetic sensors that can replicate the proven capability of the marine mammals are presently unavailable and in need of investment by the DON.

(U) Precise underwater navigation and communication are required for effective use of UVs in all domains. In water shallower than 40 feet, problems due to multipath transmissions limit reliability to an unacceptable degree. Other solutions, possibly using retractable antennas or relay stations on the surface, may be required.

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Operational Capabilities Required Technical Developments

- **Throughput**
  - Platforms Speed and Endurance
  - High Density/Small Volume Fuel Efficient Power Systems (Batteries, Fuel Cells, Thermal Systems)
  - Sensors: Range and Resolution
  - Data Fusion
  - Underwater Communications
- **Survivability**
  - Low Observables
    - Surface Shaping
    - RAM Coatings
    - Thermal Management
    - Acoustic Signature

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Operational Capabilities - Required Technical Developments - 2

(U) UV systems will always be limited by the speed and endurance of the platform. Current promising developments for high density, small volume batteries, fuel cells and power systems are expected to lead to increased effectiveness for UVs. Much of this development is being driven by the cellular phone and laptop computer industries.

(U) Recent advances in sonar technology have led to the development of Synthetic Aperture Sonar (SAS) and to broadband, multifrequency sonars, increasing both the range and resolution of acoustic sensors.

(U) Sensor fusion requires precise navigation. Advances in navigation and computing technologies will enable multisensor fusion. On-board processing technology needs improvement to become commensurate with the restriction on communications throughput (pipe size). Attention must be paid to the interpretation of fused data so as to maximize effectiveness and decision-making capabilities.

(U) All of the recent developments in low observable technology and signature reduction should be applicable to UVs. They promise to increase the survivability of air, ground, underwater and surface vehicles.

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Operational Capabilities
Required Technical Developments

- **Launch and Recovery**
  - Decreased Vehicle and Payload Size and Weight
    - Composite Material
    - Efficient Power Systems
    - Miniaturization of Sensors
  - Autonomous L&R or expendable
- **Buried Mine Detection**
  - Lower Frequency Sonar (Side Looking, Synthetic Aperture)
  - Broad Band Transduction and Signal Processing
  - Multi-static Acoustics
  - Chemical Detection
  - Ground Penetrating Radar (Beach)
  - Magnetic Sensor (SQUID)
  - Multi- and Hyperspectral IR

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Operational Capabilities - Required Technical Developments - 3

(U) These two issues are presented last because they may be the hardest. The problems associated with the launch and recovery (L&R) of UVs may prevent their effective use, if they are too high risk to use or too easy to lose. A concerted effort must be made to reduce payload size and weight as well as cost. Adaptation of autonomous L&R systems is essential, with an ultimate goal of achieving expendable systems.

(U) As we have noted often above, we are particularly concerned about the detection of buried mines. Several technologies may be applicable to this problem; namely, those that involve advances in sonars, signal processing, multi-static acoustics, chemical detectors, etc. Ground penetrating (electromagnetic) radar is used by industry now for utilities mapping; (Laser Imaging Detection and Ranging) LIDAR system and hyperspectral imaging techniques have been developed by DOE to map underground energy fields and aquafirs. It has been shown that some or all of these systems have the potential to detect buried/proud mines. We recommend that the DON partner with other agencies such as Army and DOE, and with the private sector to further explore the promise of these technologies. Partnering with academia on the development of various electro-optic (EO) (LIDAR) techniques is also recommended.

(U) In summary, we see no need to develop new platforms in the UAV or USV arena; rather, we recommend leveraging work already done by the other services and government agencies. Emerging technology can be applied most

fruitfully to sensor and system issues, including communication, navigation and data fusion/interpretation.

NRAC

Technology Longpoles

- Buried mine detection
- Underwater communications in shallow water
- Precise underwater navigation
- Data fusion for common tactical picture
- Operation in 40 feet and less (VSW & SZ) region
- Launch and Recovery

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Technology Longpoles

(U) There are a few specific technology issues which need particular attention to make effective use of UVs for mine countermeasures, as well as for more general use in littoral warfare in general.

(U) These have all been discussed in the previous slides and their importance to the MCM mission and littoral warfare are highlighted.

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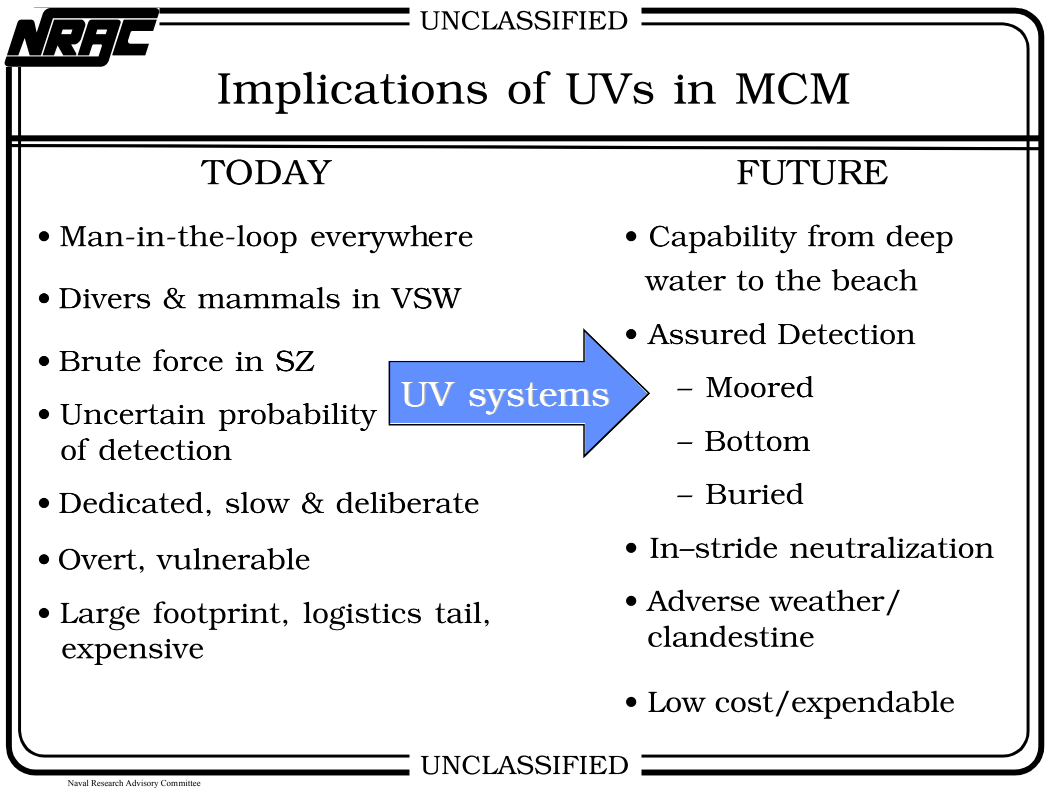

Implications of UVs in MCM

(U) The left side of the above chart delineates the characteristics of the current MCM systems. Humans are involved in nearly every step; operations are slow, deliberate, overt and vulnerable. The systems are expensive, dedicated, and have a large footprint and long logistics tail.

(U) We envision a family of UV systems that can operate across the entire domain, providing assured detection, identification and in-stride neutralization.

(U) While this slide might suggest that UVs will be silver bullets, we do not believe that. We *do* believe that many of these capabilities can eventually be realized in a family of UV systems. These UV systems have the potential to close the gap between mine development/deployment and mine clearing.

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MCM Today (U)

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(U) In VSW, divers provide both the bathymetry and hydrographic assessment. Cimatology is used to assess whether the divers can go into this zone, or which sensors may be best.

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MCM: Current direction (U)

(U) This slide depicts the various systems in the acquisition pipeline:

ALMDS - Airborne Laser Mine Detection System for detecting moored mines.

AMNS - Airborne Mine Neutralization System for neutralizing moored and bottom mines from a helicopter.

ASQ-20X - Airborne sonar towed by helicopters to detect, classify, and ultimately identify mines.

LMRS - Long-term Mine Reconnaissance System deployed from submarines with sensor suites (essentially to protect submarines from mines).

RAMICS - Rapid Airborne Mine Clearance System for neutralizing moored mines from helicopters.

RMS - Remote Minehunting System, deployed from surface combatants to detect, classify, and ultimately identify mines.

SAHRV - Semi-Autonomous Hydrographic Reconnaissance Vehicle which provides bathymetry, hydrography; can carry sidescan sonars for mine reconnaissance.

SWIMS - Shallow Water Influence Minesweeping System deployed from helicopters.

(U) The UAV carries a suite of sensors: radars, multi-spectral Infra-red (IR), EO, fused to a common picture .

(U) Note that the divers and mammals are still in the picture, although no longer in the foreground as the only available systems. There are still question marks in this picture, indicating that although some systems are in the pipeline, or in a demonstration phase, it is not clear that an effective capability will exist in the near future.

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Recommendation #1

CNR:

Solve key technical problems

- Develop biomimetic sonars aimed at buried mine detection
- Elevate priority of work on sensor data interpretation and fusion
- Elevate visibility of sensor problem to attract researchers with new ideas
- Maintain long-term investments - solve
  - Power
  - Acoustic and non-acoustic communications and sensors
  - Precise navigation
  - Autonomous control
- Leverage developments in UV technologies with Army, industry, other government agencies and academia

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Recommendation #1

(U) One of the most glaring gaps in the future MCM programs, and current vulnerabilities is the DON's dependence upon the marine mammals for buried mine detection. The panel believes that the highest priority should be given to understanding this remarkable capability. Their "sonars" have evolved over time. We need to understand how they do their sensing and how they process and utilize the data they receive.

(U) We believe that the sensor issue is the most critical one and that its importance needs to be elevated in priority.

(U) Effective sensor data fusion and interpretation will help in ultimately reducing the logistical footprint of these systems, through less reliance on highly trained technical experts, and in streamlining the decision making process.

(U) Critical technologies that currently limit the utility of UV's in all water zones include power supplies (i.e. batteries and fuel cells); acoustic and non-acoustic communication, both sensors and systems designed specifically for use in the VSW and SZ; and precise navigation and autonomous control. Sustained investment in these areas is required if the DON is to realize their potential.

(U) It is important to leverage ongoing developments in UV and sensor technologies with industry, the Army, other government agencies and the academic research community.

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Recommendation #2

CNO and CMC specify and ASN(RD&A) develop and acquire a family of UV system capabilities for end-to-end coverage throughout the threat environment.

- Drive down the acquisition and life cycle costs
- Stress modular design, power, sensors
- Minimize weight and footprint
- Provide innovative launch & recovery systems to extend operational capabilities in adverse weather

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Recommendation #2

(U) The essence of this recommendation is to *keep your eye on the ball.*

(U) The problem of assessing the mine threat and then neutralizing if necessary will require a so-called toolbox; i.e. a family of systems. Although it cannot be completed yet, we encourage the DON to take this view of what is needed.

(U) To make the targets concrete, we believe that the cost should be comparable to today's expendables, and that UV weight should be limited to that which could be carried by one person.

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Recommendation #3

CNO/CMC:

Advance Mine Warfare Core Competency

- Expedite acquisition and fielding of MCM UV programs under development
- Incorporate UV technology into future MCM programs

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Recommendation #3

(U) Significant steps have been taken to establish mine warfare as a DON core capability. In order to stay the course set by the Chief of Naval Operations (CNO) and Commandant of the Marine Corps (CMC), namely to make it a prime warfighting area as important as strike, the DON must sustain momentum created by the lessons learned in the Gulf War. To do so, we must expedite the fielding of some of the systems under development and leverage further progress through their operation in the Fleet. There is no "silver bullet" or single system that will meet the existing threat, and we must accept the possibility of some shortfall in performance. We must not resign the responsibility by terminating all programs that fail to meet advance expectations, as was done in the past. To the contrary, some systems must be placed into fleet operation and their technology assessed and evolved into future systems.

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Recommendation #4

CNO/CMC expand the MCM Concept Of Operations (CONOPS) to fully integrate UVs into the Mine Warfare Mission

- Integrate in Joint doctrine
- Insist on end-to-end capability

In coordination with DASN(Mine/Undersea Warfare):

- Iterate CONOPS with the acquisition community as technology evolves

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Recommendation #4

(U) Little guidance for the future use of innovative and capable platforms is provided in the absence of a CONOPS for MCM which includes and integrates UVs. We urge that such a CONOPS be developed and that it be in tune with technical reality. It should be integrated with Joint doctrine and able to provide the requirements which shape supporting R&D activities.

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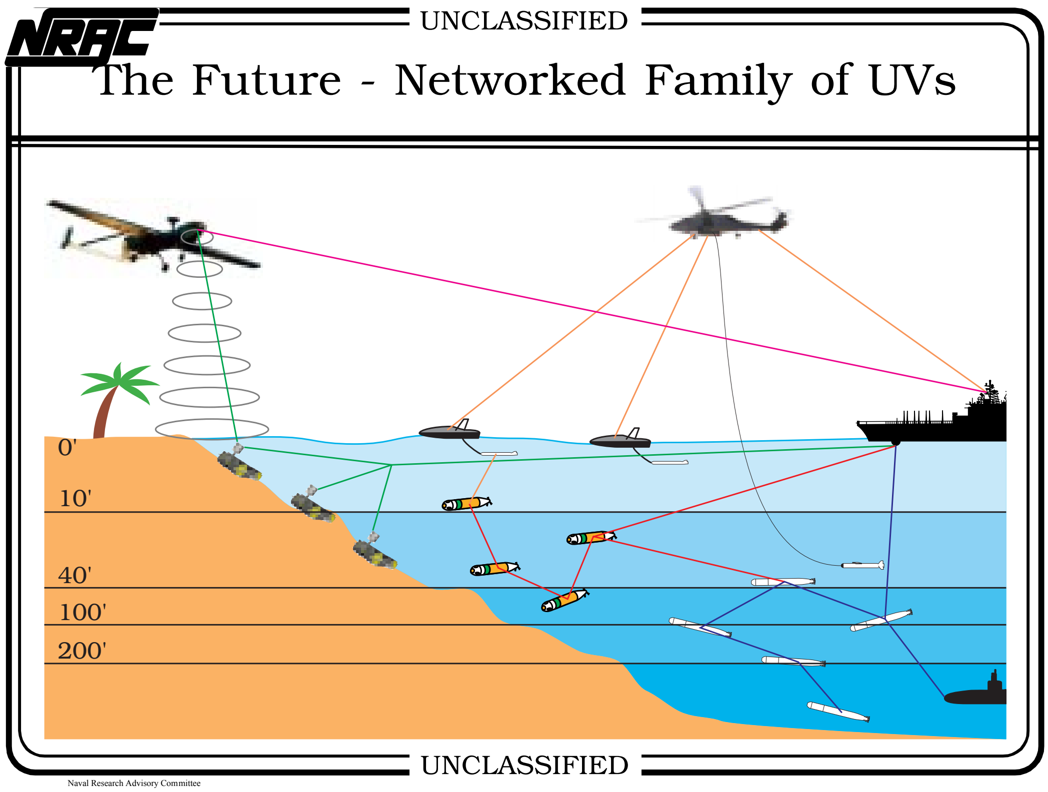

The Future - networked family of UVs

(U) Recalling the previous slides and comparing today's systems with a view of the future, we can imagine families of UVs which are networked to provide redundant, clandestine capabilities to locate, identify and neutralize mines across the entire MCM domain.

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APPENDIX A

TERMS OF REFERENCE
NAVAL RESEARCH ADVISORY COMMITTEE
PANEL ON UNMANNED VEHICLES FOR MINE COUNTERMEASURES

BACKGROUND: In the history of warfare, there are many examples illustrating that the deployment of new technology can be a major war-winning factor. There is wide agreement that UV technology will be such a factor someday, and there are several reasons why it would be highly desirable for that day to be soon:

- Zero public tolerance for combat casualties.
- Potential value in mine countermeasures.
- Established need for UVs in support of organic mine countermeasures.
- Desire to translate information superiority into tangible advantage.

OBJECTIVES: To state the requirement for UVs that would operate in support of the mine warfare mission. Identify the UV alternatives which apply to the MCM, describe them, assess their pros and cons, review the current development programs, and identify gaps and overlaps. Report findings and recommendations.

SPECIFIC TASKING:

1. Assess and evaluate status of science and technology of UVs:

- Navy and Marine Corps
- Army
- Air Force
- Foreign
- Commercial

2. Assess relative need for increased benefit from UVs in, for example, the following areas:

- Surveillance, detection, classification, identification and neutralization
- Ordnance delivery
- Reconnaissance and sensing

3. Considering both benefits and technical feasibility, assess potential options for, for example, the following:

- Sea and air operation
- Vehicle size and weight-bearing capability
- Remotely piloted and autonomous operation
- Complexity and ease of use
- Real-time communications and avionics
- Training and supportabililty

4. Identify technology and institutional blockers to the effective development of UVs aimed at various requirements.

5. Recommend focus and level of effort appropriate for development and deployment efforts in light of the benefits derivable, the state of the art, and various blockers.

POINTS OF CONTACT: Major General Dennis Krupp, USMC
Director, Expeditionary Warfare (N85)
Office of the Chief of Naval Operations

Captain John Nawrocki, USN @ 703/697-1428

APPENDIX B
LIST OF BRIEFINGS

3 May 1999
Review of USN/USMC Mine Countermeasures Requirements - CDR Gilliland (N852), LTCOL Len Blaisol (MCCDC)
Review of MCM S&T for Organic Mine Warfare - Dr. Doug Todoroff (ONR 32)
Review of UUV Requirements/UUV Master Plan - Mr. Henery Gonzalez (PMS 403)
Review of UAV Requirements - Col Terry Robling (N853)
Review of UAV S&T - Dr. Allen Moshfegh (ONR 35)

4 May 1999
Review of UUV/UAV S&T - Dr. Tom Curtin (ONR 32)
UMV S&T Programs for VSW MCM - Dr. Tom Swean (ONR 32)
Review of MCM Acquisition Program - PEO (MIW), PMS (EOD), PMS 210, PMS 407
Review of UAV Acquisition Programs - Mr. Dave Maddox, Mr. Greg Catrambon/PEO (Cruise Missiles/UAVs)
Review of DARPA Programs - Mr. Larry Birckelbaw

17 May 1999
Welcome and NUWCDIVNPT Overview - Captain Walter Elliott
UUV Acquisition & Technology Overview - Paul M. Dunn
UUV Semi Fuel Cell - Eric G. Dow
UUV Integrated Motor Propulsor - Daniel P. Thivlerge
UUV Silencing - Donald J. McDowell
US/French Non-Traditional Navigation - Robert N. Carpenter
Geo-Physical Navigation - Christopher Shaw
UUV Autonomy (21 UUV Testing Results) - Michael J. Keegan
UUV Autopilot - Theodore C. Gagliardi
Oceanographic Sensors - Edward R. Levine
Lemmings - Christiane N. Duarte
Mine Warfare Sensors & Technology - Raytheon Company
MIT Briefing

18 May 1999
Control Systems for Unmanned & Autonomous Vehicles - Dana Yoerger
Acoustic Methods for Mine Location & Identification - Ralph Stephen
Underwater Acoustic Communication - Mark Johnson, Dan Frye
Small Vehicles/REMUS, SHARF - Chris Von Alt
ABE & Control Systems & Power Issues - Al Bradley
IS Robotics - Polly Pook

3 June 1999
Executive Station Overview - Mr. Barry Dillon

Littoral Warfare/The Future - Mr. Barry Dillon
The Value of Unmanned Vehicles (UV) - Mr. Paul Pettofrezzo
History of UV Systems @ CSS - Dr. Ace Summey
Mine Countermeasures Threat Brief - Mr. Andy Dinkins
UV Technology/Advanced Sensing (Sonors, Gradiometry, Electro-Optics) - Dr. John Lathrop
CAD/CAC & Data Fusion - Dr. Jerry Doebeck
UVs & the Tactical Control System (TCS) - Dr. Ron Peterson
Coastal Battlefield Recon & Analysis (COBRA) - Mr. Ned Witherspoon
Very Shallow Water/Surf Zone MCM - Mr. Steve Castelin
UV Systems Hardware Tour - AIROPS Hanger
Surf-Zone UV-TCS Demo - Dr. Ron Peterson
Advanced Sensors - Dr. John Lathrop
CAD-CAC Demo - Dr. Jerry Dobeck
COBRA Multi-Spectral Sensors - Mr. Ned Witherspoon
Remote Minehunting System (RMS) Prototype - Mr. Guy Santora
Very Shallow Water UV - Mr. Bruce Venanzi
Modern Mine Threat - Mr. Bob Backus
Littoral UV Applications (Current & Future)
Remote Minehunting System (RMS) - Mr. Guy Santora
Joint Countermeasures ACTD - Mr. Dave DeMartino
Swimmer Delivery Vehicles - Mr. Dave Brewer
Sea Wasp - Mr. Steve Hudson

4 June 1999
Overview of Ocean Engineering and the South - Peter Tatro (NSRDC-CD)
Florida Ocean Measurement Center (SFOMC) - Stan Dunn
Review of SFOMC In-water Assets & Joint Programs - Ed An
AUV Technology at FAU - Sam Smith, Ken Holappa, P. Ananthakrishnan, Ed An
Acoustics Technology at FAU - Stewart Glegg, Lester LeBlanc, Joe Cuschieri
Ocean Turbulence Measurements - Manhar Dhanak, Ken Holappa

24 June 1999
Review of MIT UUV Programs - Mr. Henrik Schmidt
UMV Sensors and Sensor Study - Dr. Randy Jacobson (ONR 321)
ONI Briefing - Mr. Ed McWethy, Ms. Jean Avery, Mr. Gordon Shelley
New Technologies for Mine Warfare - Mr. Walt Rankin (CSS)
Review of Penn State/ARL Programs - Dr. Ray Hettche

25 June 1999
Review of MCM Acquisition Programs - CAPT Ahern (PMS 407)
Review of MIT/Bluefin UUV Technology - Mr. Jim Bellingham
Review of UMV Technology Programs - Dr. Theresa McMullen (ONR)
Review of US Army UAV/MCM Technology

APPENDIX C

SECDEF Letters to SECNAV

THE SECRETARY OF DEFENSE
1000 DEFENSE PENTAGON
WASHINGTON, DC 20301-1000

12 November 1997

The Honorable John H. Dalton
Secretary of the Navy
1000 Navy Pentagon
Washington, DC 20350-1000

Dear John,

Thank you for the informative brief on Mine Warfare. I am encouraged to know that both you and CNO are taking a personal interest in ensuring that our effort to move toward an organic MIW capability stays on track, in accordance with the FY96 Campaign Plan and our former CNO's White Paper.

As I mentioned during our meeting, we have still not convinced the skeptics, and I have been among their ranks for a long time. In fact, Defense News' Nov 10-16 article erroneously implies that my "concerns are mollified" where Mine Warfare is concerned. While we all have the best of intentions in our articulations on this subject, the prevailing opinion is that once again the Navy's commitment to its own Mine Warfare Plan is waning. Our critics do not miss the fact that across FY97-01 budget lines, we are imposing an 18% reduction on our MIW programs (using FY97 as a baseline). A 10% decrease in PR99 alone provides further evidence of this trend. I am also concerned that the decision to cancel the AQS-20 advanced sonar sends yet another negative signal in this regard.

John, I believe that the Navy is one disaster away from unprecedented criticism with regard to its commitment to Mine Warfare since the Gulf War. I am convinced that the Navy has the capability to bring to bear the necessary technologies to bridge the gap between our cold war home port breakout capability, and our new direction towards an organic capability imbedded both in the fleet and in the consciousness of our naval officers. While I recognize that you and Admiral Johnson have had some very difficult choices to make during the past year, I would appreciate your re-evaluation of your actions with regard to Mine Warfare, especially mine countermeasures. I have asked PA&E to give me their assessment of the AQS-20 program from a programmatic perspective. We all agree that the investment in and the potential of this capability is significant. While there are few programs these days that should be earmarked as untouchable, I think that any collective failure to recognize and implement the urgent imperatives of the Mine Warfare program could have serious consequences for our Navy. I urge both you

and the CNO to redouble your efforts in this regard. I would appreciate periodic updates as well as a full briefing prior to next year's Mine Warfare certification to the Congress.

CF:

Deputy Secretary of Defense
Chairman, Joint Chiefs of Staff
Chief of Naval Operations
Commandant of the Marine Corps

THE SECRETARY OF DEFENSE
1000 DEFENSE PENTAGON
WASHINGTON, DC 20301-1000

7 April 1998

The Honorable John H. Dalton
Secretary of the Navy
1000 Navy Pentagon
Washington, DC 20350-1000

Dear John,

Thank you for the informative FY99 Mine Warfare certification briefing. I both noted and appreciated the presence of the Department of the Navy's Senior Leadership at the table as we reviewed this year's progress towards our goal of achieving an organic MIW capability for the Navy. As I mentioned during our meeting, I remain concerned about the lack of commitment of necessary resources to bring about the desired transformation of mine warfare within the shortest possible time. Over the past several years we have spent a great deal of our resources on RDT&E programs, none of which have resulted in any transition to production. We cannot continue in this manner in the future.

It is time to fully comply with the will and intent of the Congress which has provided clear guidance with regard to the Nation's expectations of the Navy. I ask that you take the following actions with regard to mine warfare: First, that you "fence" the Naval Mine Warfare Programs from further funding reductions until such time as we have crossed the threshold from the dedicated capability we currently have to the organic capability we seek to acquire. Second, that you not use the dedicated MIW Force to "pay the bills" in the transformation process. We will need the current force to respond to the very real threats our forward deployed forces face until we can make the crossover. In other words, the operational readiness of the current force continues to be very important. Third, I would ask that you develop a "POM" for mine warfare which balances requirements and resources. Our conversation indicated that presently we are not in balance in that requirements exceed resources allocated. You may find the Mine Warfare Front End Assessment, currently being conducted by PA&E, to be helpful in this effort. I would appreciate a follow on brief when this is done. My goal is to be of assistance to you in this effort. Lastly, I would appreciate hearing more with regard to your plans to "mainstream" mine warfare into the consciousness of the fleet. I would imagine that you are giving thought to the educational requirements as well as to the operational imperatives associated with this important effort. Our Marines and Sailors must be mine warriors in addition to everything else we expect of them.

This is an exciting time for the Navy as it moves to full implementation of the congressional will and our vision for Naval Mine Warfare. By your dedication and ultimate success, you will send a clear message to those who would engage our forces asymmetrically, and that message will be one which convinces them of the futility of their purpose.

I appreciate your leadership and support in this important undertaking.

Copy Furnished:

Admiral J.L. Johnson, Chief of Naval Operations
General Charles C. Krulak, Commandant of the Marine Corps

THE SECRETARY OF DEFENSE
WASHINGTON, DC 20301-1000

JAN 8 1999

MEMORANDUM FOR DEPUTY SECRETARY OF DEFENSE
SECRETARY OF THE NAVY
UNDER SECRETARY OF DEFENSE (COMPTROLLER)
CHIEF OF NAVAL OPERATIONS
COMMANDANT OF THE MARINE CORPS

SUBJECT: DON Mine Countermeasures (MCM) Funding

I want to commend Navy leadership for its Mine Warfare Fleet Engagement Strategy and investment plan. I am pleased to see that while much attention is correctly focused on initiating an organic mine warfare capability for our Navy in the mid-term, your near-term priorities still include continued support of our dedicated forces. I am also pleased to note in your budget submit that your POM investment strategy includes resources to bring about this organic capability. I support these initiatives and encourage you to accelerate any efforts that are technically feasible and I also support your ongoing efforts to "mainstream" mine warfare.

To that end, I have directed that an additional $315 million be added to the Department of the Navy Total Obligation Authority increase, fully funding the Navy's organic mine warfare initiatives through the FYDP. In doing this, it now becomes critical for the Navy to translate the "organic vision" to executable programs and deliver the organic MCM capability to the fleet. Therefore, it is imperative that senior Navy management attention be given to ensure successful integration of the airborne MCM program into the CH-60s, as well as successful fleet introduction of the Remote Minehunting System, the Long-term Mine Reconnaissance System, and other new systems.

Additionally in providing this funding, I want to reiterate my long-standing concerns and guidance for future budget cycles. First, Naval Mine Warfare Programs should be fenced from further funding reductions until the organic capabilities we require have been achieved; second, the readiness of the dedicated MIW Force should not be jeopardized to pay for the desired organic capability; and third, you continue to resource the requirements of the mine warfare program.

Again, I appreciate your leadership and continued efforts to deliver this important warfare capability to the Fleet.

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APPENDIX D

Acronyms

ACU	Amphibious Craft Unit
AFOSR	Air Force Office of Scientific Research
AFRL	Air Force Research Laboratory
AIRMCMRON	Air Mine Countermeasures Squadron
AIROPS	Air Operations
ALMDS	Advanced Laser Mine Detection System
AMCM	Airborne Mine Countermeasures
AMNS	Airborne Mine Neutralization System
ARL	Applied Research Laboratory or Army Research Laboratory
ASN(RD&A)	Assistant Secretary of the Navy (Research, Development, and Acquisition)
ASQ-20X	Airborne Towed Sonar
AUV	Autonomous Unmanned Vehicle
BDA	Battle Damage Assessment
CAD/CAC	Computer-Aided Design/Computer-Aided Construction
CLZ	Craft Landing Zone
CMC	Commandant of the Marine Corps
CNN	Cellular Neural Network
CNO	Chief of Naval Operations
COBRA	Coastal Battlefield Reconnaissance and Analysis
COMMINEWARCOM	Commander Mine Warfare Command
COMEODGRU	Commander Explosives Ordinance Group
COMOMAG	Commanding Officer Mobile Mine Assembly Group
COMTHRIRDFLT	Commander Third Fleet
CONOPS	Concept of Operations
CORP	Corporation
COTS	Commercial Off-the-Shelf
CSS	Coastal System Station
CTR	Center
C^3	Command, Control and Communications
DARPA	Defense Advanced Research Projects Agency
DASN	Deputy Assistant Secretary of the Navy
DEF	Defense
DET	Distributed Explosive Technology or Detachment
DoD	Department of Defense
DOE	Department of Energy
DON	Department of the Navy
EO	Electro-Optic
EOD	Explosive Ordnance Detachment
EOID	Electro-Optic Identification
EST	Establishment

FAU	Florida Atlantic University
FL	Florida
FRG	Federal Republic of Germany
GPS	Global Positioning System
ID	Identification
IFO	International Field Office
INC	Incorporated
IR	Infra-red
ISR	Intelligence, Surveillance and Reconnaissance
JHU	Johns Hopkins University
JTFC	Joint Task Force Commander
LAB	Laboratory
LCAC	Landing Craft Air Cushion
LIDAR	Laser Imaging Detection and Ranging
LMRS	Long-Term Mine Reconnaissance System
L&R	Launch and Recovery
m	Meter
MCCDC	Marine Corps Combat Development Command
MCM	Mine Countermeasures
MCS	Mine Command Ship
MCMRON	Mine Countermeasure Squadron
MEF	Marine Expeditionary Force
MI	Mile
MIT	Massachusetts Institute of Technology
MMS	Marine Mammal System
MRC	Major Regional Conflict
NASA	National Aeronautics and Space Administration
NAVAIRSYSCOM	Naval Air Systems Command
NAVSEASYSCOM	Naval Sea Systems Command
NDI	Non-Developed Item
NOMBOs	Non-Mine Mine-Like Objects
NRAC	Naval Research Advisory Committee
NRL	Naval Research Laboratory
NSWC	Naval Surface Warfare Center
NUI	Naval Undersea Institute
NUWC	Naval Undersea Warfare Center
ONI	Office of Naval Intelligence
ONR	Office of Naval Research
OPNAV	Office of the Chief of Naval Operations
PEO (MIW)	Program Executive Officer (Mine Warfare)
PEO (CU)	Program Executive Officer (Cruise Missile and Unmanned Vehicles)
PMS	Program Manager Ships
RAM	Radar-Absorbing Material
RAMICS	Rapid Airborne Mine Clearance System
R&D	Research and Development

RMS	Remote Minehunting System
SAMs	Surface-to-Air Missiles
SAS	Synthetic Aperture Sonar
SABRE	Secured Airborne Radar Equipment
SAHRV	Semi-Autonomous Hydrographic Reconnaissance Vehicle
SECDEF	Secretary of Defense
SECNAV	Secretary of the Navy
SFOMC	Southern Florida Ocean Measurement Center
SLOC	Sea Lines of Communication
SMCM	Surface Mine Countermeasures
SPAWARSYSCOM	Space and Naval Warfare Systems Command
SQUID	Superconducting Quantum Interference Device
SSC	SPAWAR System Center or Stennis Space Center
S&T	Science and Technology
SW	Shallow Water
SWIMS	Shallow Water Influence Minesweeping System
SYS	Systems
SZ	Surf Zone
TCS	Tactical Communications System
TUAV	Tactical Unmanned Aerial Vehicle
UAV	Unmanned Air Vehicle
UGV	Unmanned Ground Vehicle
UHF	Ultra High Frequency
UNIV	University
USMC	United States Marine Corps
USV	Unmanned Surface Vehicle
UUV	Unmanned Underwater Vehicle
UV	Unmanned Vehicle
UVA	University of Virginia
VSW	Very Shallow Water
VTUAV	Vertical Takeoff Unmanned Aerial Vehicle

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